# Environmental Flow Regime Assessment and Development of a Monitoring Framework

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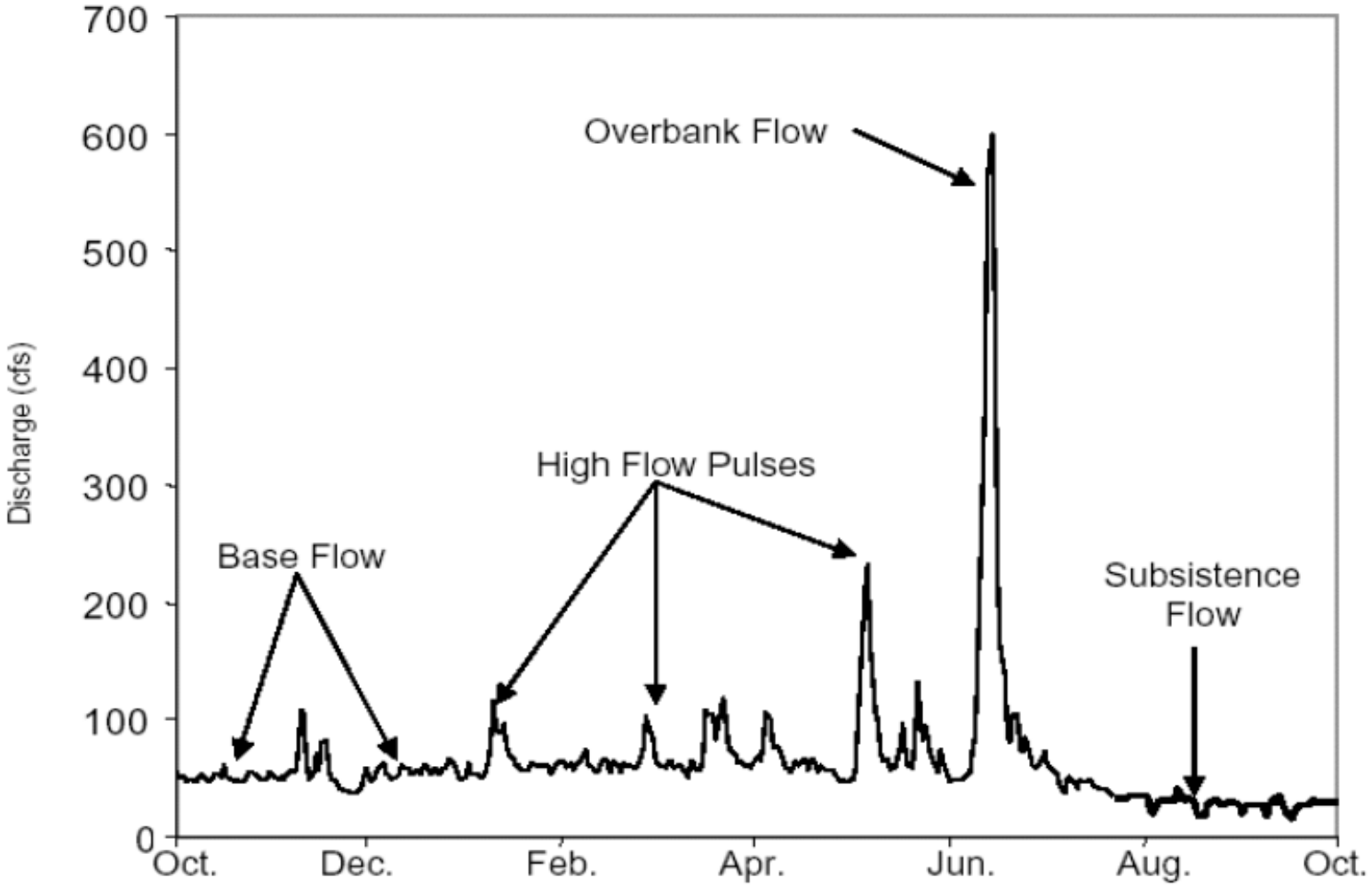
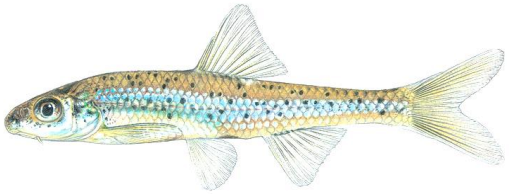
## *Table 4.1-15. GSA BBASC Environmental Flow Regime Recommendation - Guadalupe River at Cuero*[49]

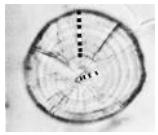
| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Overbank Flows** | Qp: 45,400 cfs with Average Frequency 1 per 5 years<br>Regressed Volume is 869,000<br>Duration Bound is 91 | | | | | | | | | | | |
| | Qp: 24,700 cfs with Average Frequency 1 per 2 years<br>Regressed Volume is 406,000<br>Duration Bound is 64 | | | | | | | | | | | |
| | Qp: 16,600 cfs with Average Frequency 1 per year<br>Regressed Volume is 247,000<br>Duration Bound is 50 | | | | | | | | | | | |
| **High Flow Pulses** | Qp: 4,610 cfs with Average Frequency 1 per season<br>Regressed Volume is 55,300<br>Duration Bound is 26 | | | Qp: 8,870 cfs with Average Frequency 1 per season<br>Regressed Volume is 110,000<br>Duration Bound is 32 | | | Qp: 2,110 cfs with Average Frequency 1 per season<br>Regressed Volume is 19,300<br>Duration Bound is 17 | | | Qp: 5,200 cfs with Average Frequency 1 per season<br>Regressed Volume is 54,700<br>Duration Bound is 23 | | |
| | Qp: 1,610 cfs with Average Frequency 2 per season<br>Regressed Volume is 14,100<br>Duration Bound is 13 | | | Qp: 3,370 cfs with Average Frequency 2 per season<br>Regressed Volume is 31,800<br>Duration Bound is 18 | | | Qp: 1,050 cfs with Average Frequency 2 per season<br>Regressed Volume is 8,300<br>Duration Bound is 12 | | | Qp: 1,730 cfs with Average Frequency 2 per season<br>Regressed Volume is 14,100<br>Duration Bound is 13 | | |
| **Base Flows (cfs)** | 980 | | | 940 | | | 800 | | | 870 | | |
| | | | | 680 | | | 600 | | | | | |
| | | | | 410 | | | 390 | | | | | |
| **Subsistence Flows (cfs)** | 130 | | | 120 | | | 130 | | | 86 | | |
| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
| | Winter | | | Spring | | | Summer | | | Fall | | |

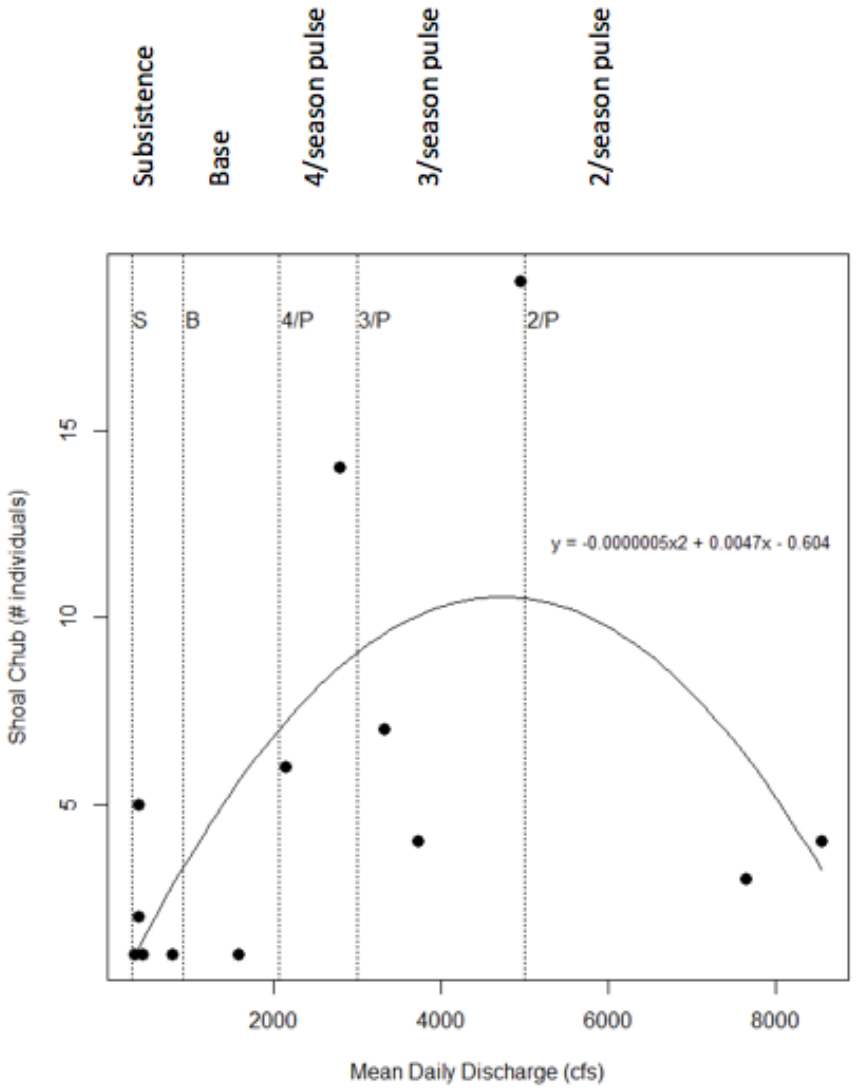

700
600
500
400
300
200
100
0
Discharge (cfs)
Overbank Flow
High Flow Pulses
Base Flow
Subsistence Flow
Oct.
Dec.
Feb.
Apr.
Jun.
Aug.
Oct.

# Rapid life cycle

Shoal chub, *Macrhybopsis hyostoma*

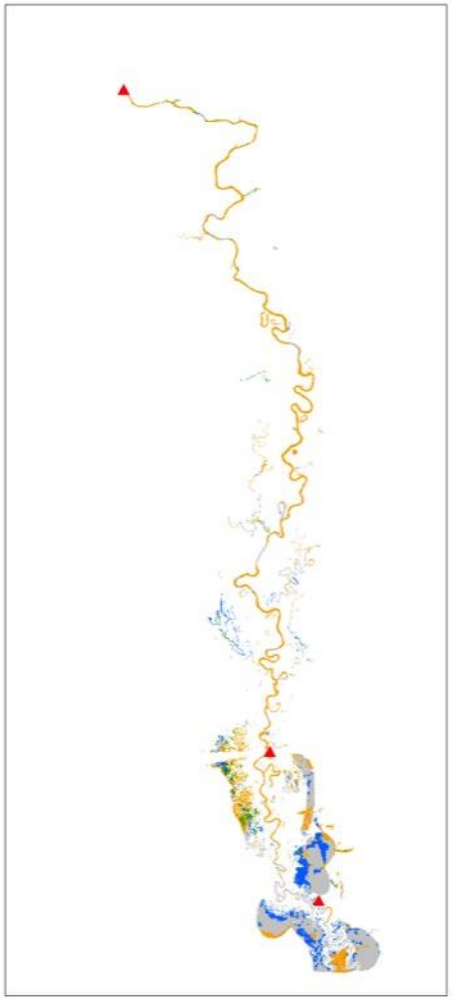






# Slow life cycle

Alligator gar, *Atractosteus spathula*



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ARTICLE

# Effects of Hydrology on Fish Diversity and Assemblage Structure in a Texan Coastal Plains River

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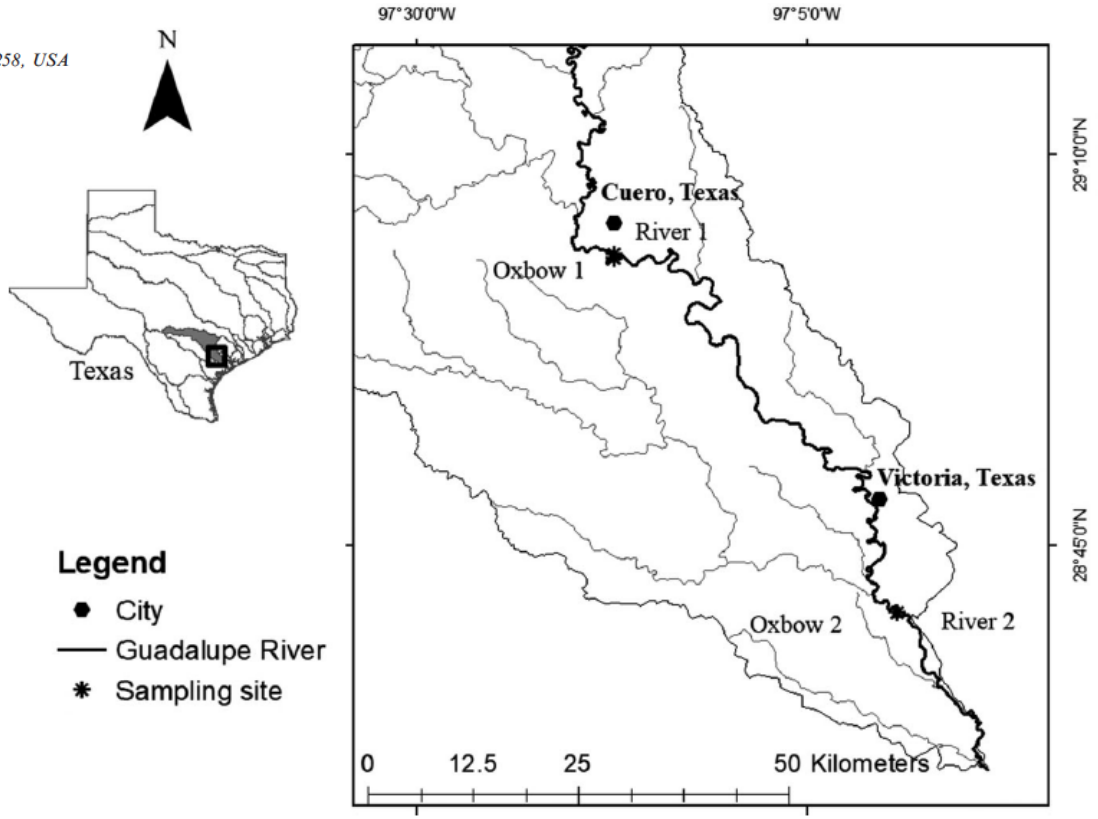

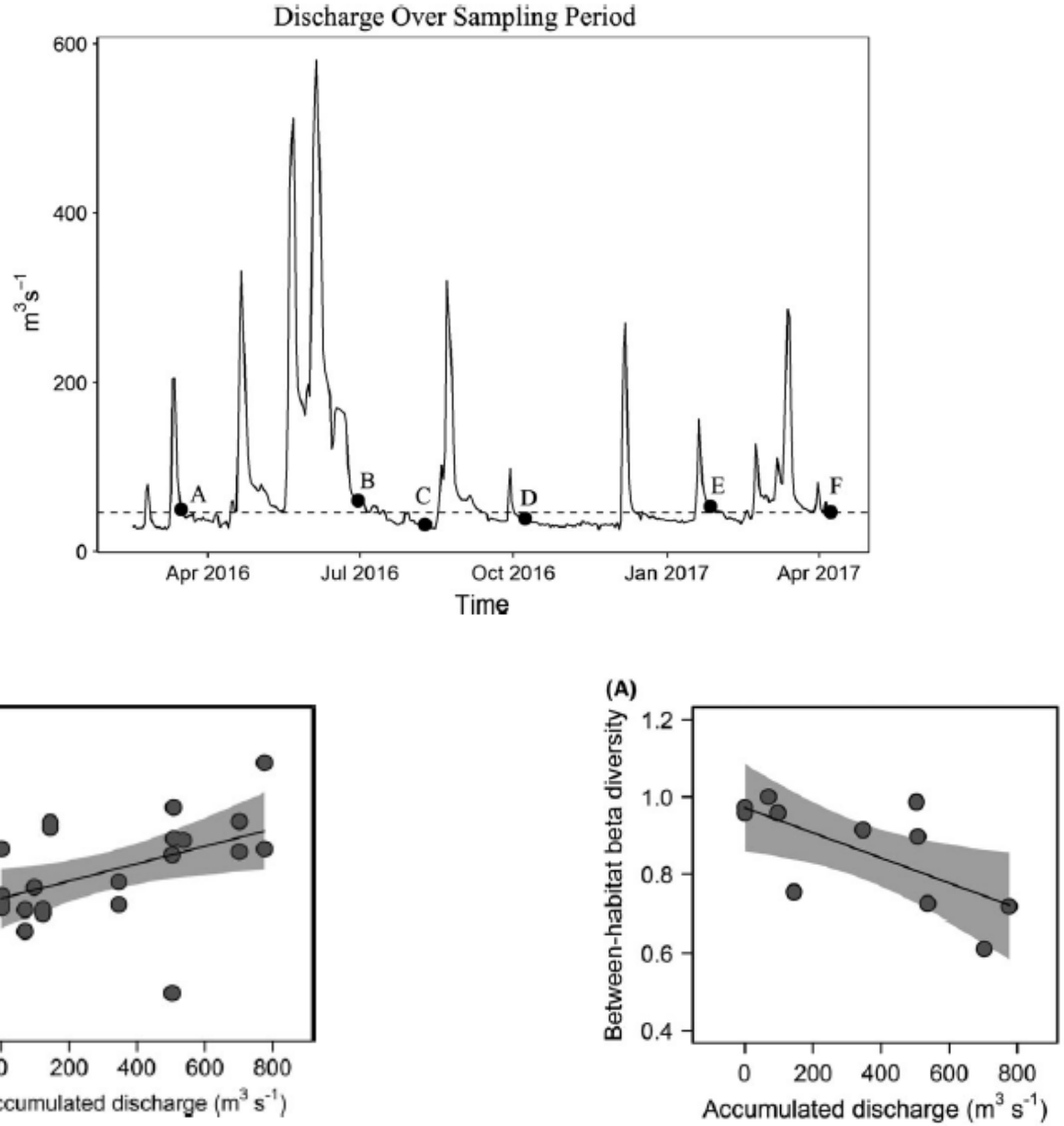


FIGURE 5. Relationship between rarefied richness (α diversity) and accumulated discharge for fish samplings conducted in the Guadalupe River, Texas. Solid line (light gray band denotes the 95% CI) represents the linear relationship using the whole data set.

TWDB RFQ No. 580-18-RFQ0067

# TITLE: Environmental Flow Regime Assessment and Development of a Monitoring Framework

TIME FRAME: March 25, 2019 to December 15, 2020


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Project Summary:

This project analyzes flow-ecology relationships according to two complementary approaches:  long-term monitoring analysis that reveals trends in the state of indicators of the system; and shorter-term retrospective analysis designed to assess responses of key indicator taxa to flow-regime components to facilitate inferences about cause and effect regarding ecological mechanisms.

Focal basins are Brazos, Colorado-Lavaca, Guadalupe-San Antonio

1. Compile existing relevant environmental flow study datasets

Review and compilation of datasets from previous studies associated with SB2 and SB3 projects as well as other investigations will be analyzed to reveal flow-ecology relationships.

Findings from these analyses will provide the basis for improved recommendations for short-term and long-term monitoring that can improve interpretation of flow-ecology relationships and evaluation of environmental flow standards.

2. Perform analysis of ecological attributes of the flow regime using existing datasets

Emphasis will be on correlative approaches, including multivariate methods, to evaluate the strength of flow–ecology relationships based on time intervals of variable length.

Findings from these analyses will be used to make recommendations for standardized monitoring to track the relative success of environmental flow standards over time.

3. Select flow-response indicator taxa

The most suitable indicators for retrospective flow analysis are aquatic and riparian species that are directly affected by changes in flow regime components and that can be collected in sufficient numbers to achieve reliable numerical analysis.

A. Fish, fluvial specialist with fast life history – Candidates are chubs (*Macrhybpsis* species).

B. Fish, flow-dependent with slow life history – Candidate is alligator gar (*Atractosteus spathula*) for which studies are ongoing in other Texas basins and regions of the US.

C. Mussel, fast life history – Candidates include: *Utterbackia imbecillis* (Colorado), *Lampsilis teres* (Guadalupe, Brazos), and *Leptodea fragilis* (Brazos).

D. Mussel, slow life history – Candidates include *Cyclonaias pustulosa* and *Amblema plicata*.

E. Riparian tree, fast life history – Candidate is black willow

F. Riparian tree, slow life history – Candidates are cottonwood, sycamore, bald cypress, green ash, box elder

4. Fieldwork to collect indicator-taxa specimens

- 3 Basins: Guadalupe, Colorado, Brazos
- 3–4 locations within lower reaches of each of the three rivers, which may include major tributaries
- habitats within locations – selected for riparian trees , mussels and fluvial specialist minnows

5. Analysis of flow-growth-recruitment relationships of indicator taxa

Retrospective analysis compares biological, physical or chemical indicators to flows that preceded the indicators in an ecologically relevant timeframe.

These analyses are consistent with the “rates” approach discussed by Wheeler et al. (2017). In the rates approach, ecological response reflects temporal change. According to Wheeler et al., “Because of their explicit or implicit links with demographic processes, rates approaches offer the potential for a more demographically mechanistic understanding of flow-ecology relationships”.

6. Demonstrate use of trend analysis for inferring flow-ecology relationships and develop guidance for long-term monitoring

Long-term monitoring allows tracking of species, functional groups of species, habitats and water quality for the purpose of evaluating trends associated with flow variation. Sources of existing data will be accessed, including those obtained from SB2 & SB3 projects conducted in the Guadalupe/San Antonio, Colorado/Lavaca and Brazos basins.

The choice of approach for generating flow-ecology relationships will influence the type of hydrologic metrics chosen for use as predictor variables (Wheeler et al. 2017). States approaches generally rely on summary metrics that characterize flow conditions over long time series, whereas rate approaches often analyze multiple flow regime components over shorter time intervals.

7. Develop guidance materials for stakeholders

- Demonstrate strategy and study design for evaluation of water allocation tradeoffs
- Use of WAM (Water Availability Model) and FRAT (convert monthly to daily flows) to simulate alternative flow scenarios
- Evaluate ecological responses to scenarios based on statistical relationships/models

  The relative change in ecological conditions from the current flow conditions to a more fully-appropriated future can support the development of strategies and identification of priorities both in terms of where and when the adverse impacts are likely to occur.

8. Develop and organize two workshops

- 1-day event for non-specialists providing overview of objectives, strategies, study elements

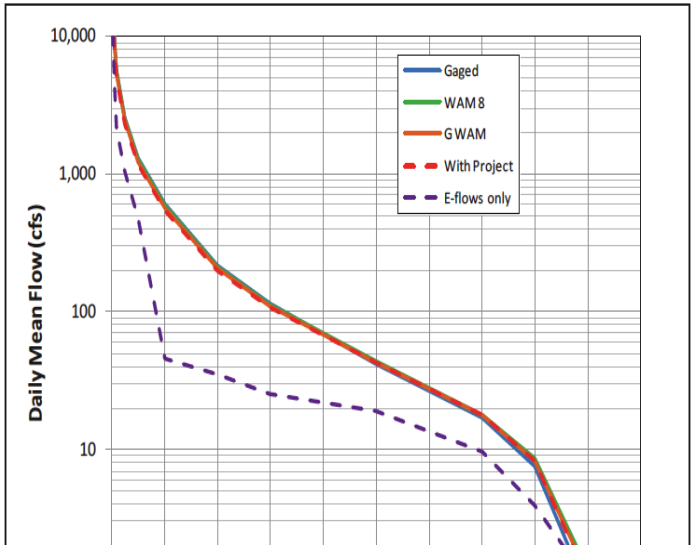
- 4-day event for technicians and scientists with instruction on study design, methods, inference, and scenario simulation/evaluation plus a session reporting workshop accomplishments to interested stakeholders

- develop a YouTube video tutorial of methods, inferences, and applications

Final note:

A major challenge is <u>to predict responses</u> of ecological components to scenarios of environmental change caused by alteration of hydrologic regimes.

| Average Annual Water and Sediment Yields | | |
|---|---|---|
| | Average Annual Yield | |
| **Hydrologic Scenarios** | **Water Acre-Feet (% of Baseline)** | **Sediment Tons per Year (% of Baseline)** |
| BRAZOS RIVER AT SEYMOUR | | |
| *Historical Flows* | | |
| 1940-1997 Gaged Flows | 246,000 (102%) | 296,000 (103%) |
| *Simulated Flows* | | |
| WAM 8 Flows (Baseline) | 242,000 (100%) | 288,000 (100%) |
| G WAM | 233,000 (96%) | 262,000 (91%) |
| G WAM with Project | 223,000 (92%) | 233,000 (81%) |
| E Flow Only | 93,400 (39%) | 56,600 (20%) |



Simulation modeling can address this last challenge, but this approach requires considerable knowledge of ecological processes plus empirical data to support model development, parameterization and testing.

## RIV WebScape Model

(currently under development at Texas A&M)